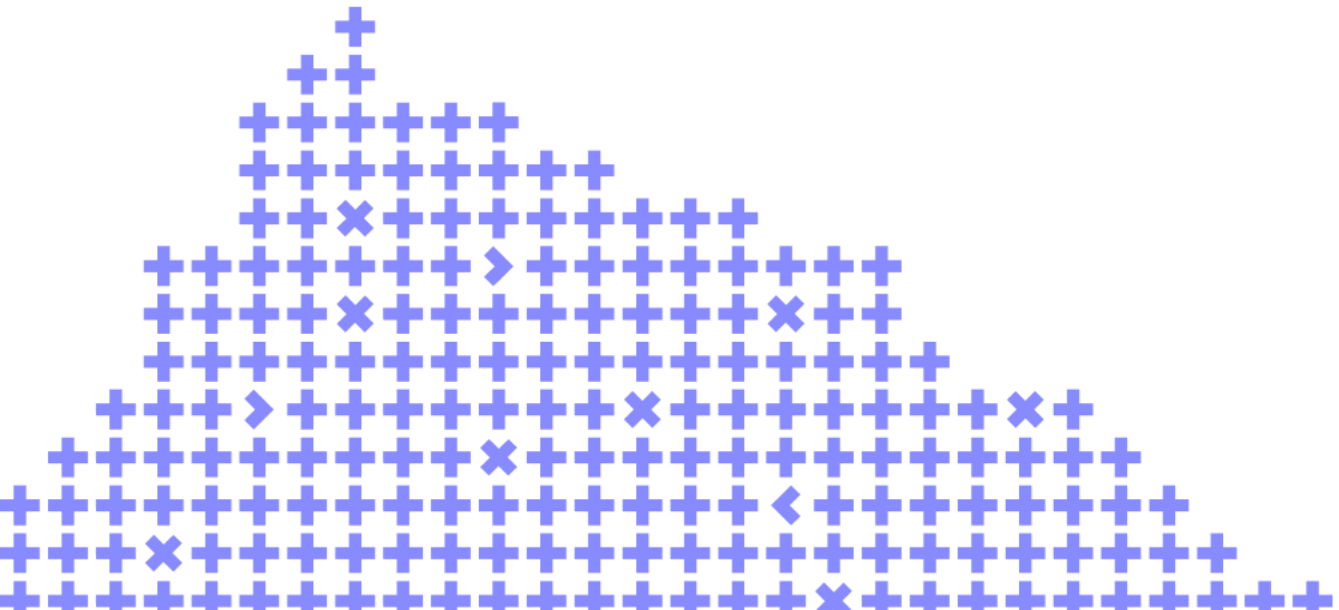
FPGA Basic Principles: An Introduction to How It Works

Lia Yepremyan



High Load Armenia

Co-organizer

Yandex

Lia Yepremyan

AMD

Senior Product Management Engineer at AMD/Xilinx

2 years working with FPGA designs
Deep knowledge of FPGA’s architecture
Also worked in ASIC flows for more than 9 years
Complete notion between differences of FPGA and ASIC design flows

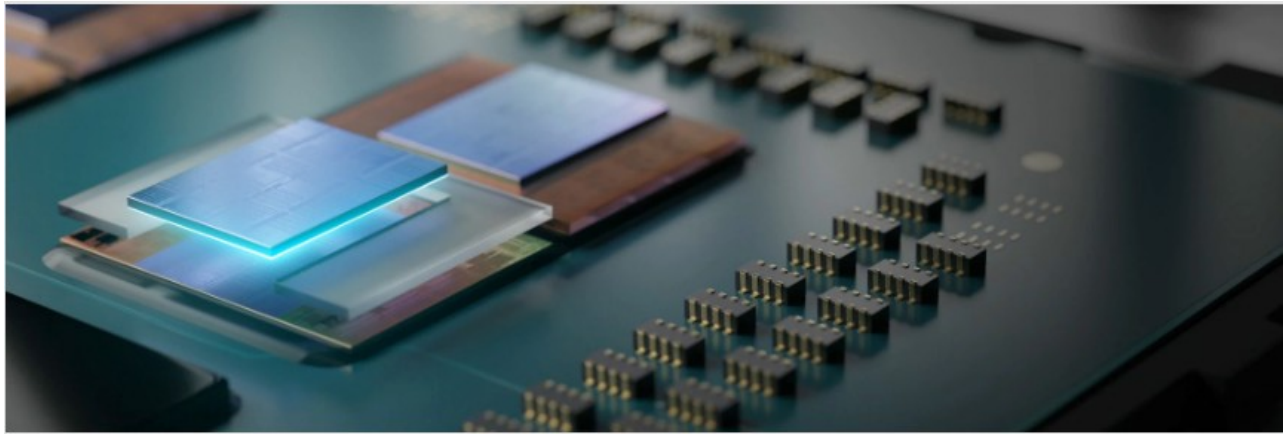
Xilinx, Inc. was a semiconductor company that primarily supplied programmable logic devices. The company was known for inventing the first commercially viable Field Programmable Gate Array (FPGA) and creating the first fables manufacturing model.

- Xilinx was founded in 1984
  - On February 14, 2022, AMD acquired Xilinx in a full stake deal.

Advanced Micro Devices, Inc. (AMD) develops computer processors and related technologies for business and consumer markets. AMD's main products include microprocessors, motherboard chipsets, embedded processors, graphics processors, and FPGAs for servers, personal computers, and embedded system applications.

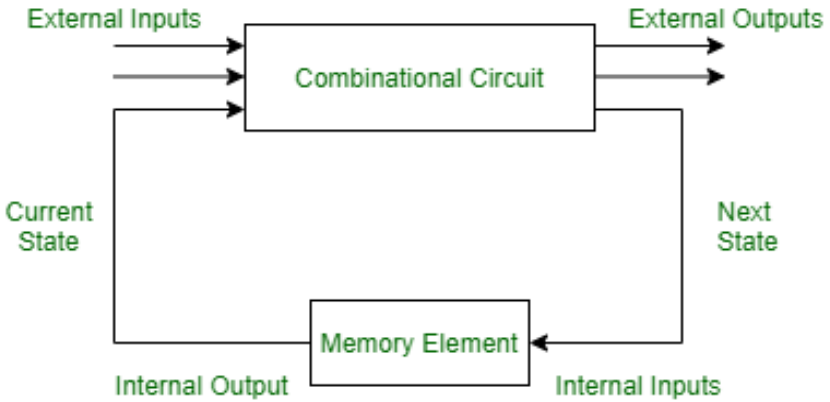
Introduction

- What is an FPGA?
- What can an FPGA be used for?
- How to program an FPGA?
- FPGA Architecture
- FPGA Applications
- Designing and Coding
- The Future of FPGAs



Hardware Circuit, FPGA

A specific hardware can be configured by a specific software to provide some functionality

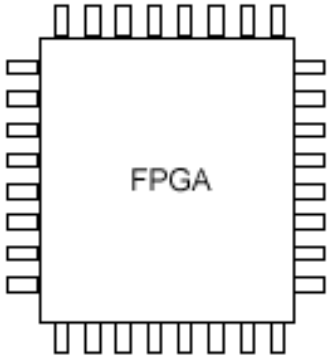


Examples of combinational circuits: **Adder, Subtractor, Converter, and Encoder/Decoder**.

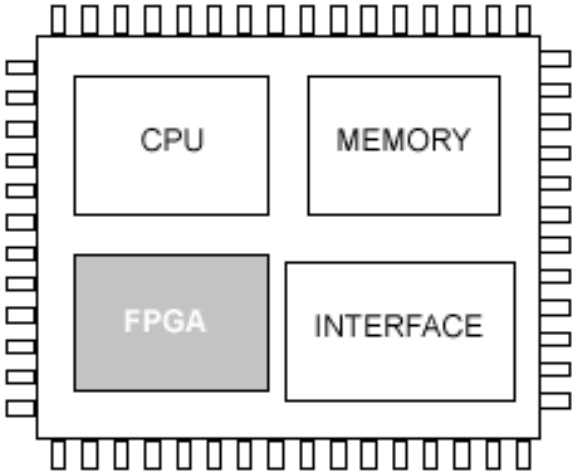
Examples of sequential circuits: **flip-flops, counter, register, clocks**, etc.

What is an FPGA?

Field programmable Gate Arrays (FPGAs) are pre-fabricated silicon devices that can be electrically programmed in the field to become almost any kind of digital circuit or system. The term “field-programmable” indicates that the FPGA’s abilities are adjustable and not hardwired by the manufacturer like other ICs (Integrated Circuits).



(a) Stand-alone FPGA

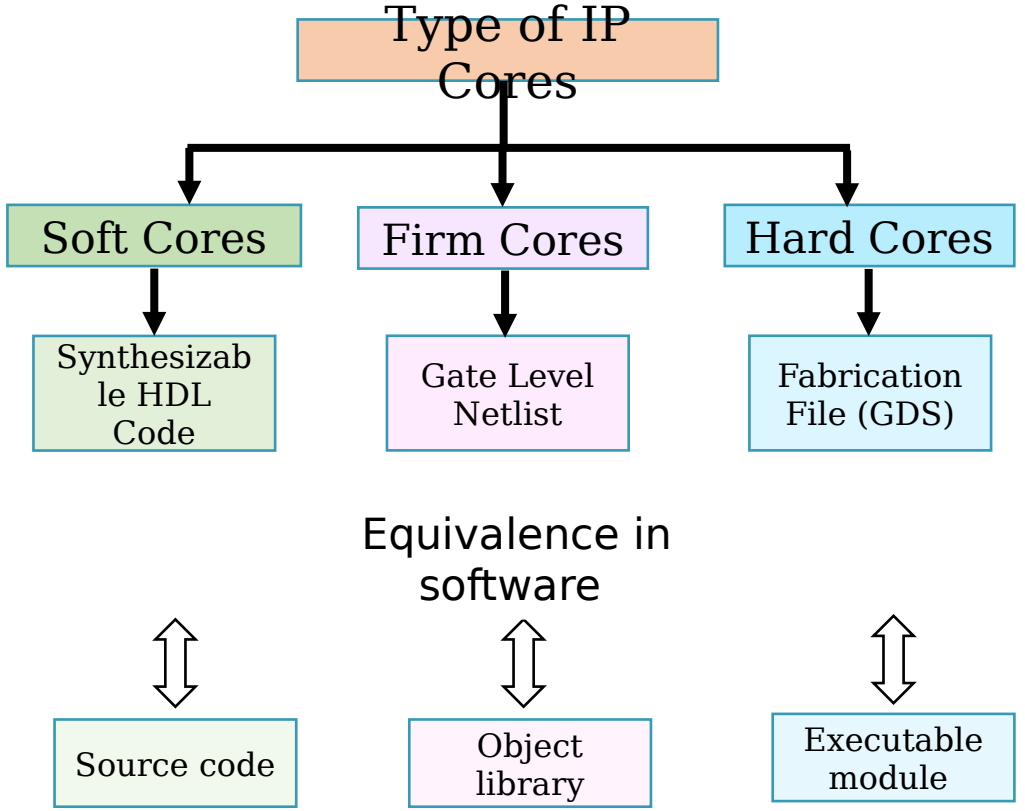


(b) FPGA as an internal block

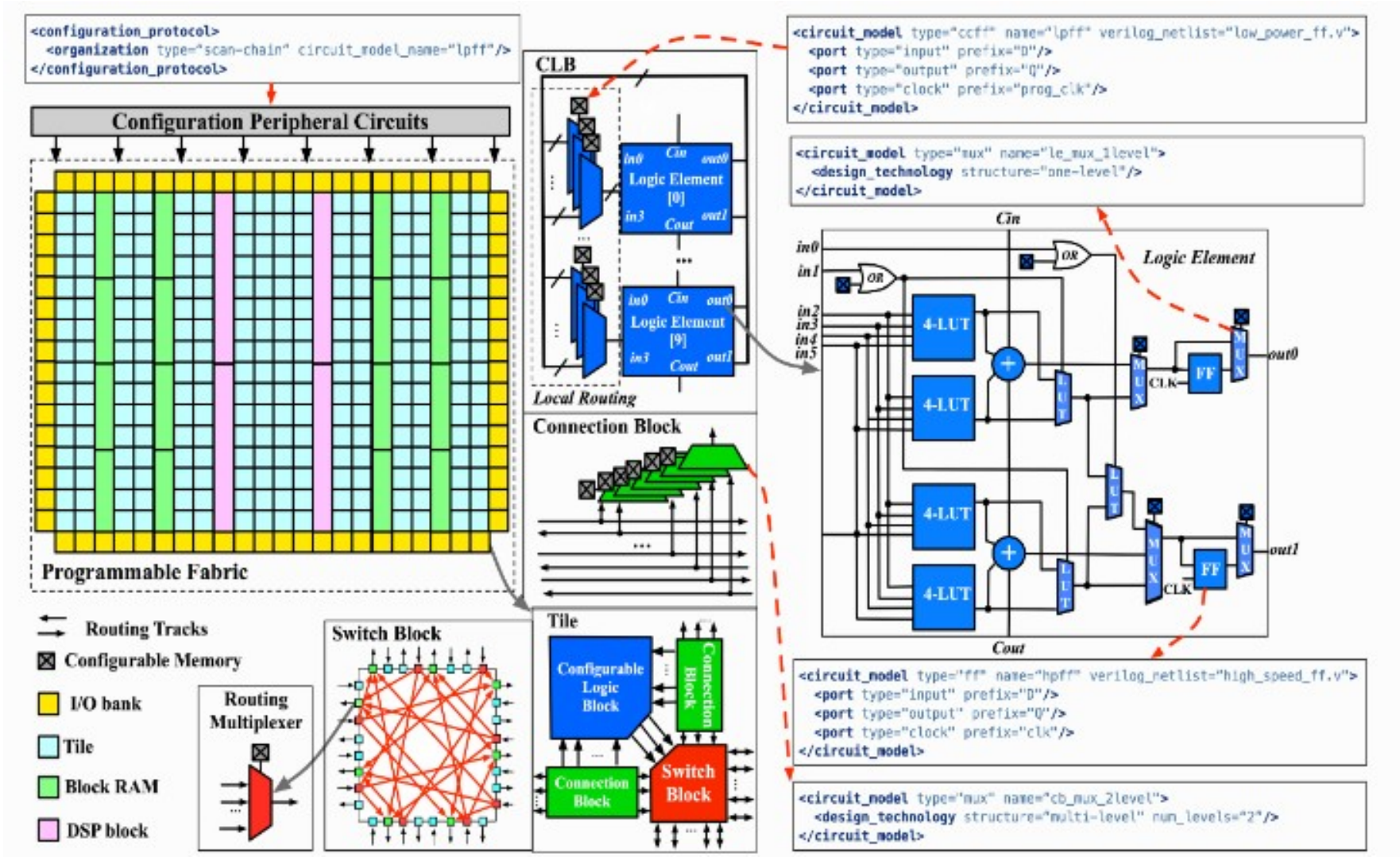
IP Cores

IP Cores support design reuse

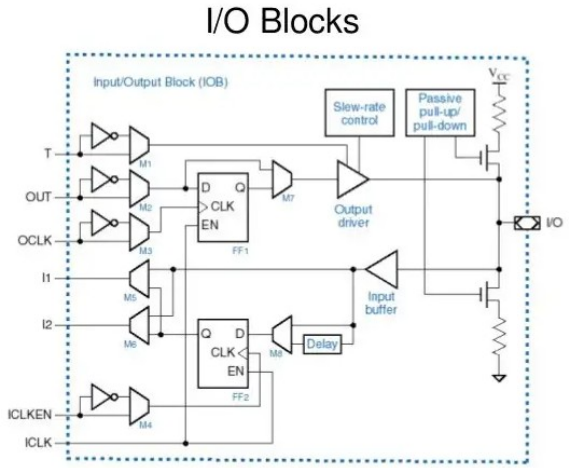
- ✓Soft IP
- ✓Firm IP
- ✓Hard IP



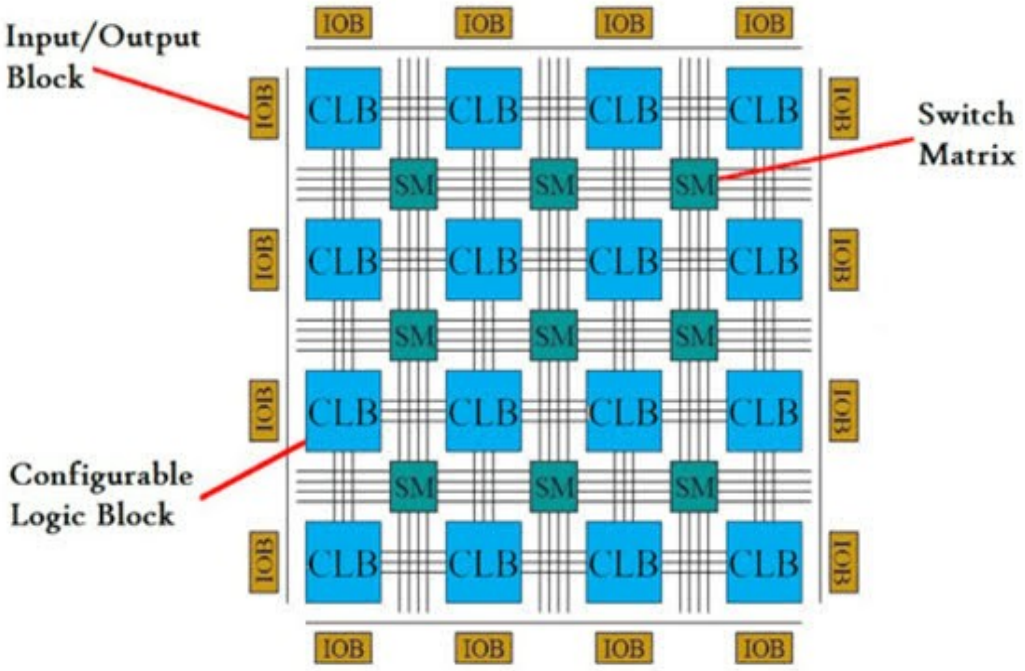
FPGA Architecture

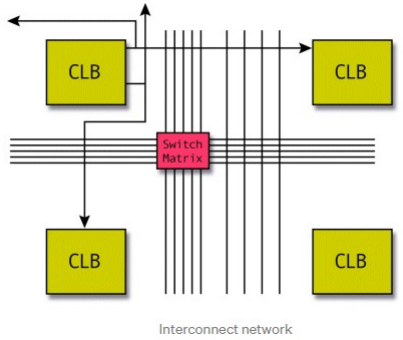


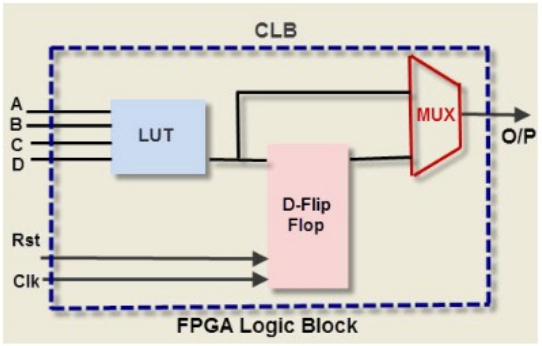
Combined Structure of FPGA



- CLB (Configurable Logic Block)
- I/O Pads or Blocks
- Switch Matrix/Interconnection Wires

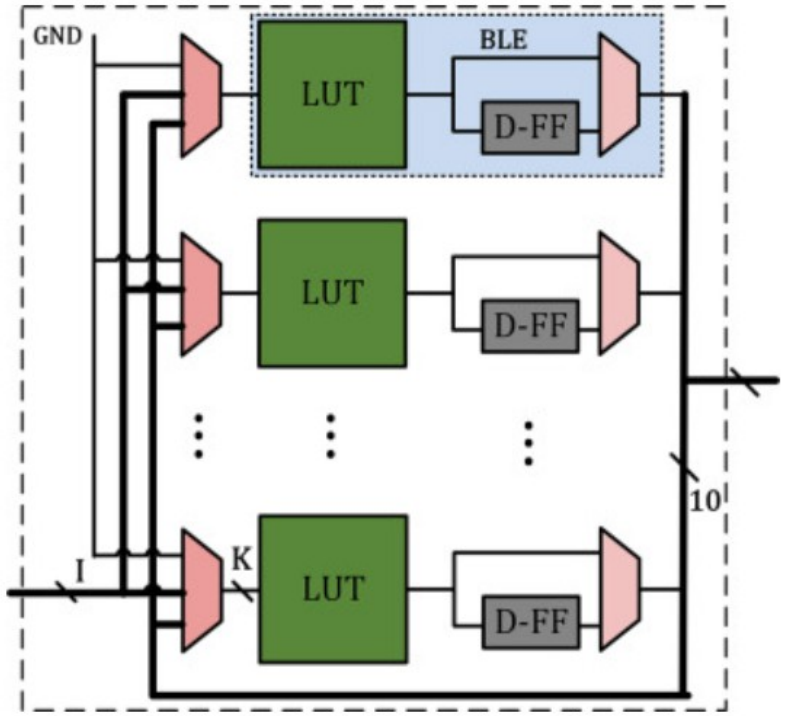






FPGA Logic Block

Configurable Logic Block(CLB)



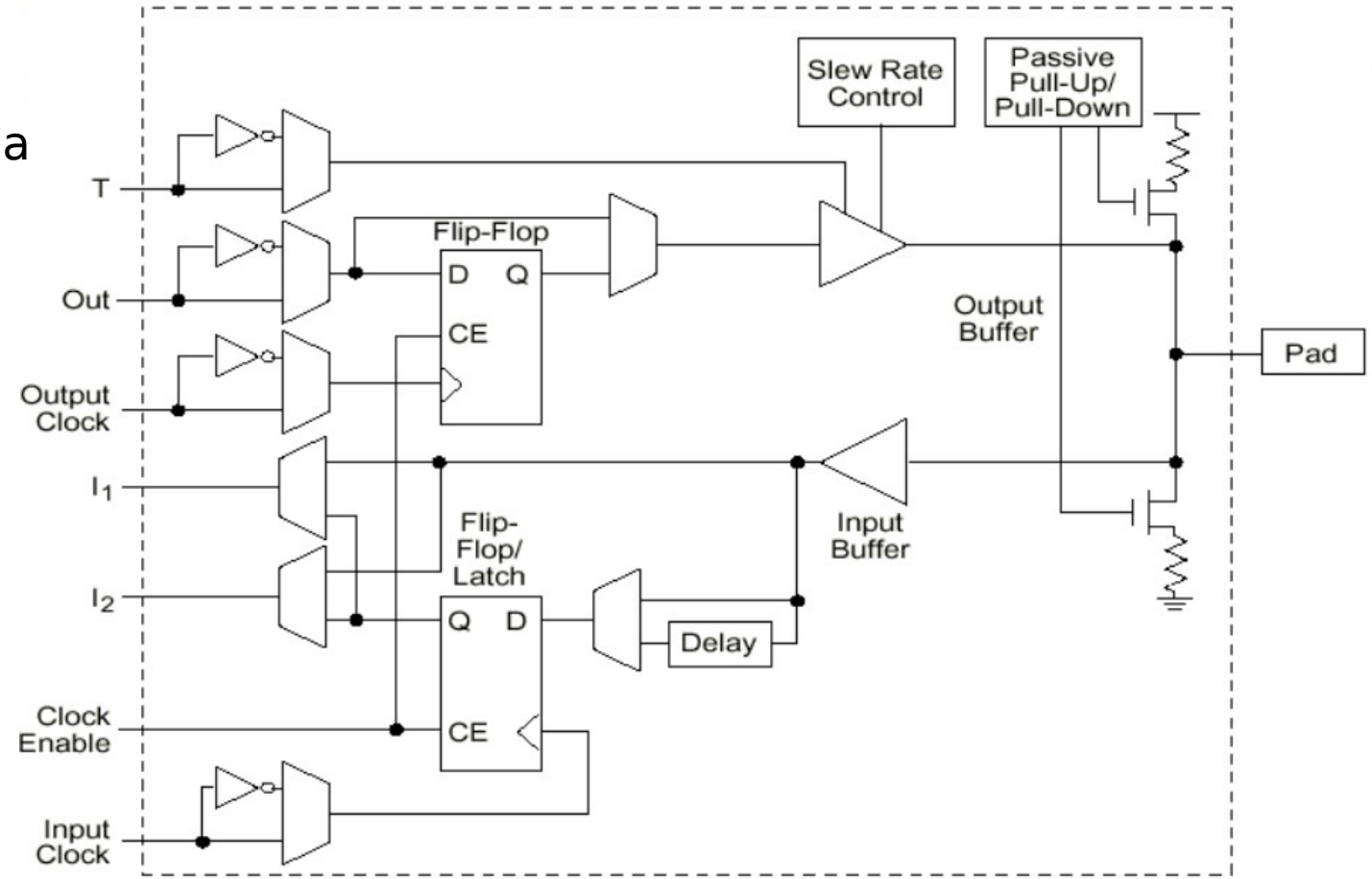
Configurable Logic Blocks

- The components responsible for implementing core logic functions.

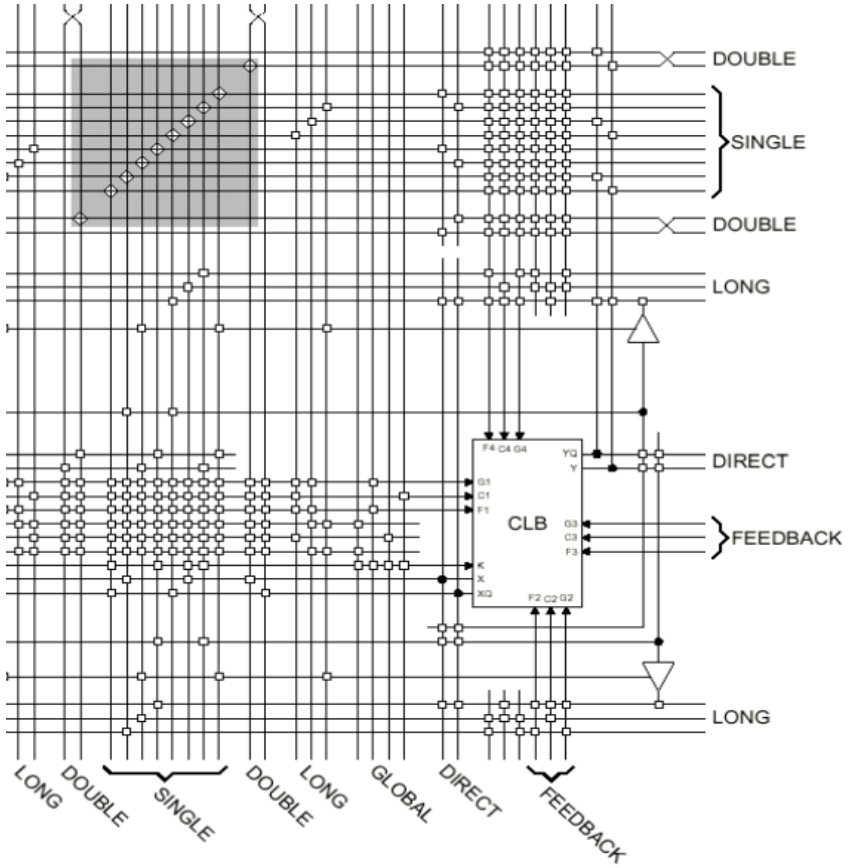
I/O Pads or Blocks

I/O blocks

- Special logic blocks at periphery of a device for external connections

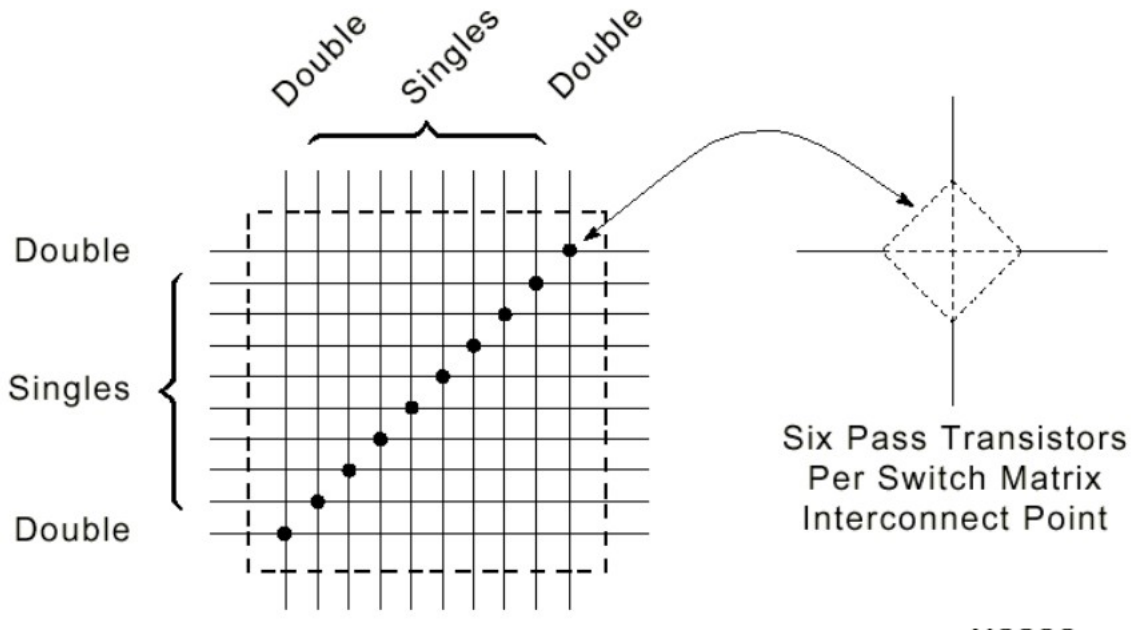


Switch Matrix/Interconnection Wires



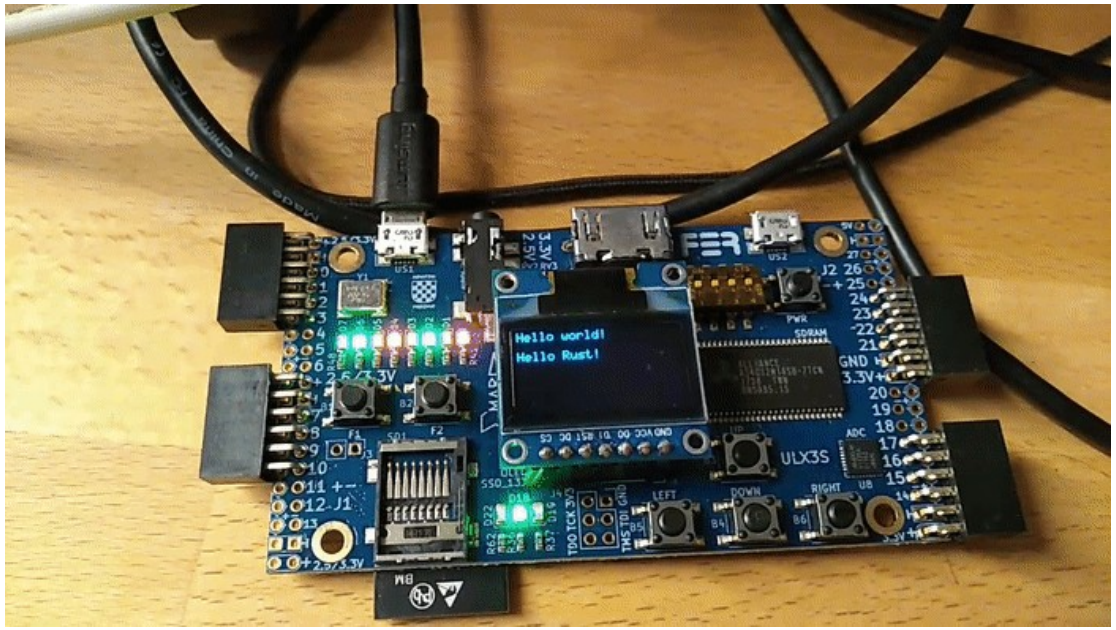
Interconnect wires

- To connect inputs and outputs to logic blocks



What Can FPGA Programming Be Used For?

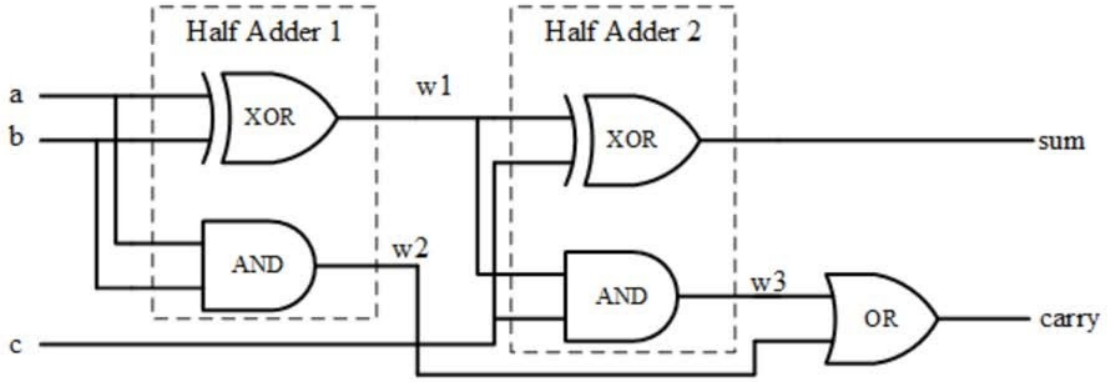
- ✓ FPGAs are used to design application-specific integrated circuits (ASICs).
- ✓ Another trend in the use of FPGAs is hardware acceleration
- ✓ FPGAs are used in projects where hardware configuration is a subject to change and a circuit that can be adjusted to these changes is called for



Save time!

Save money!

Designing and Coding



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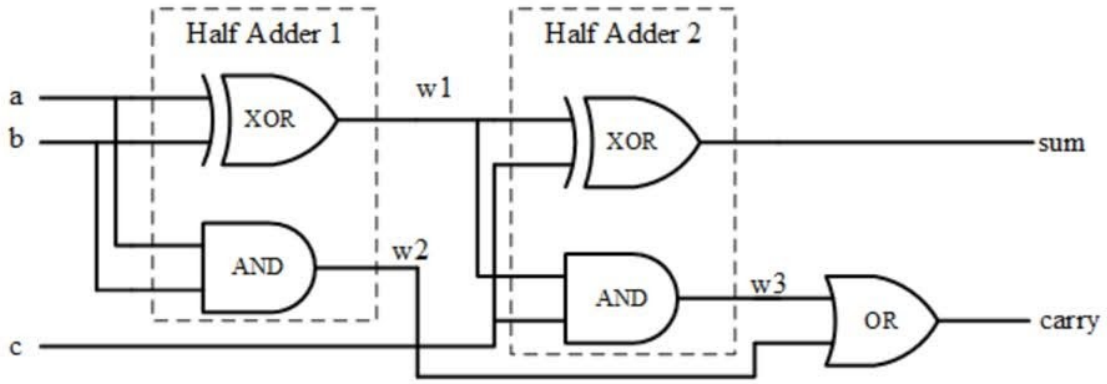



```
module HA( s, c, a, b );

input  a, b;
output s, c;

xor (s, a, b);
and (c, a, b);

endmodule
```

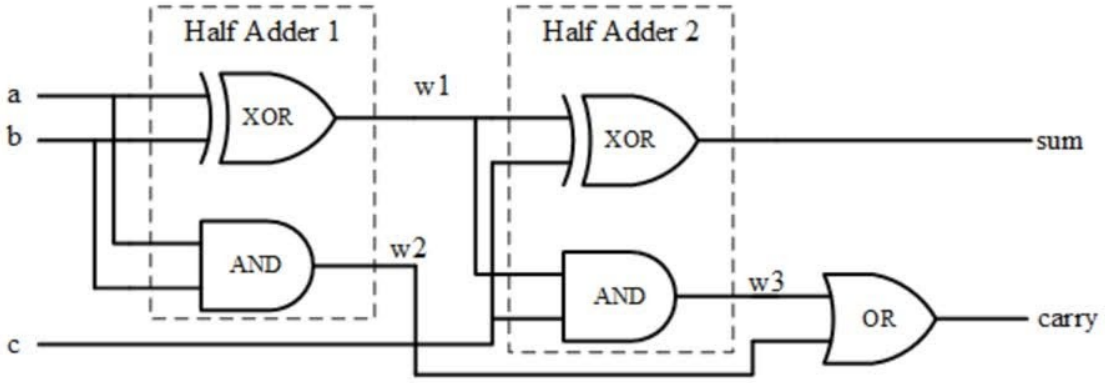
```
module FA( sum, carry, a, b, c );

output sum, carry;
input  a,   b,     c;
wire   w1,  w2,    w3;

HA HA1 (w1,    w2, a,  b);
HA HA2 (sum,   w3, w1, c);
or     (carry, w3, w2);

endmodule
```

Designing and Coding

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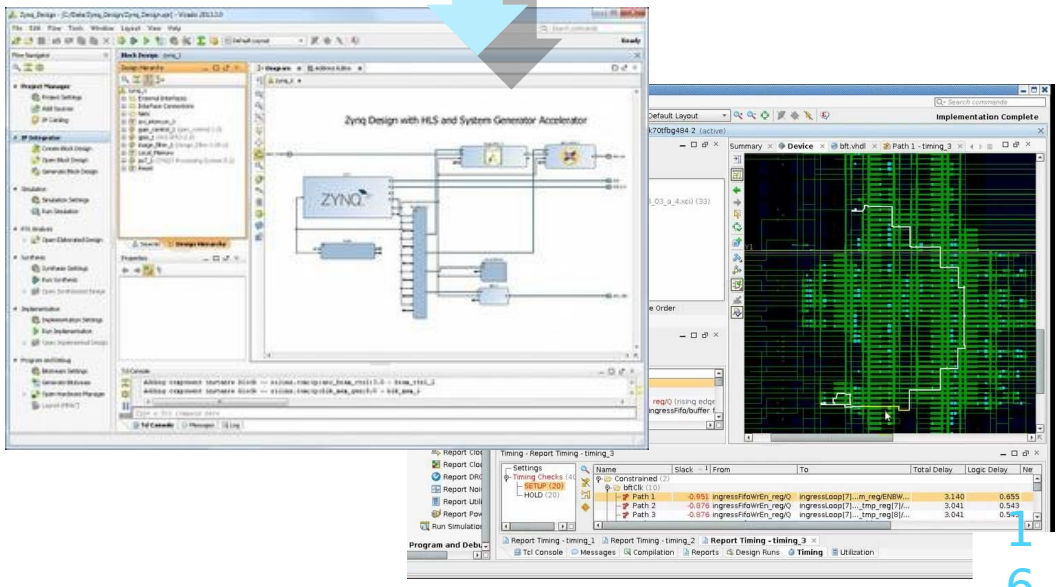

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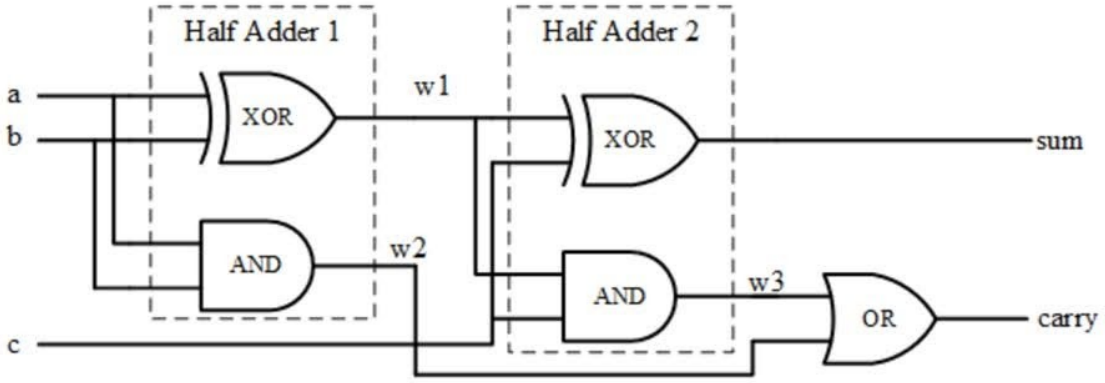


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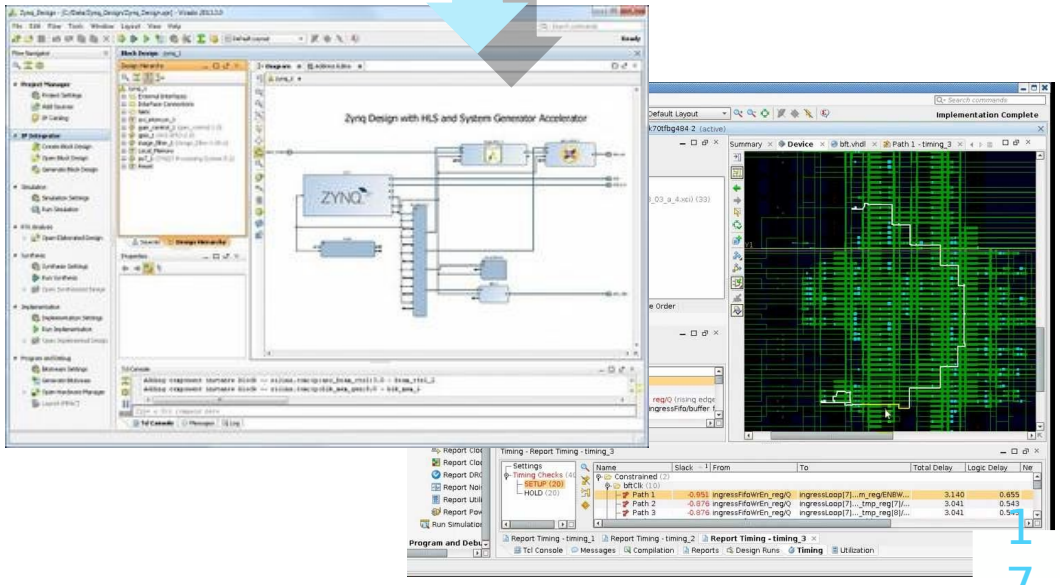
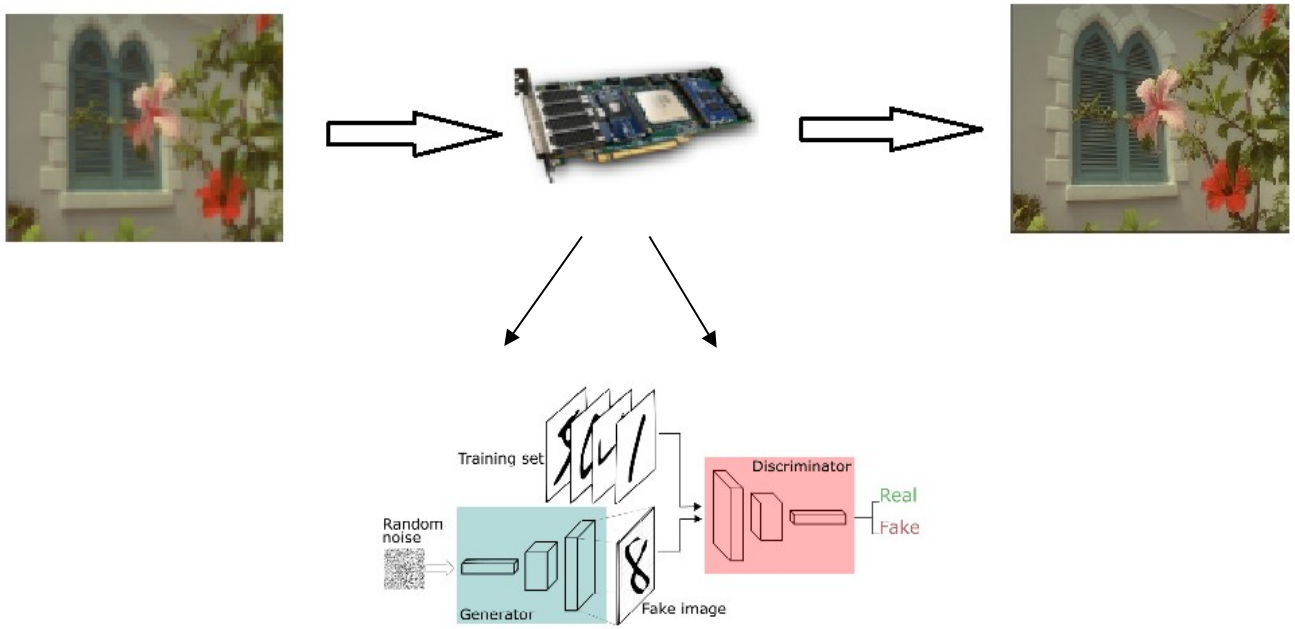


FPGA Applications

- Aerospace & Defense
- ASIC Prototyping
- Broadcast & Professional AV(Audio Visu
- Consumer Electronics
- Data Center
- Medical & Science
- High Performance Computing and Data Storage
- Video & Image Processing
- Wired Communications
- Wireless Communications

Video & Image Processing

Image Processing



- FPGAs are often used as implementation platforms for real-time image processing applications because their structure is able to exploit spatial and temporal parallelism.
- The approach used is a windowing operator technique to traverse the pixels of an image and apply the filters to them.

The Future of FPGAs

Going forward, the FPGA market is set to expand.

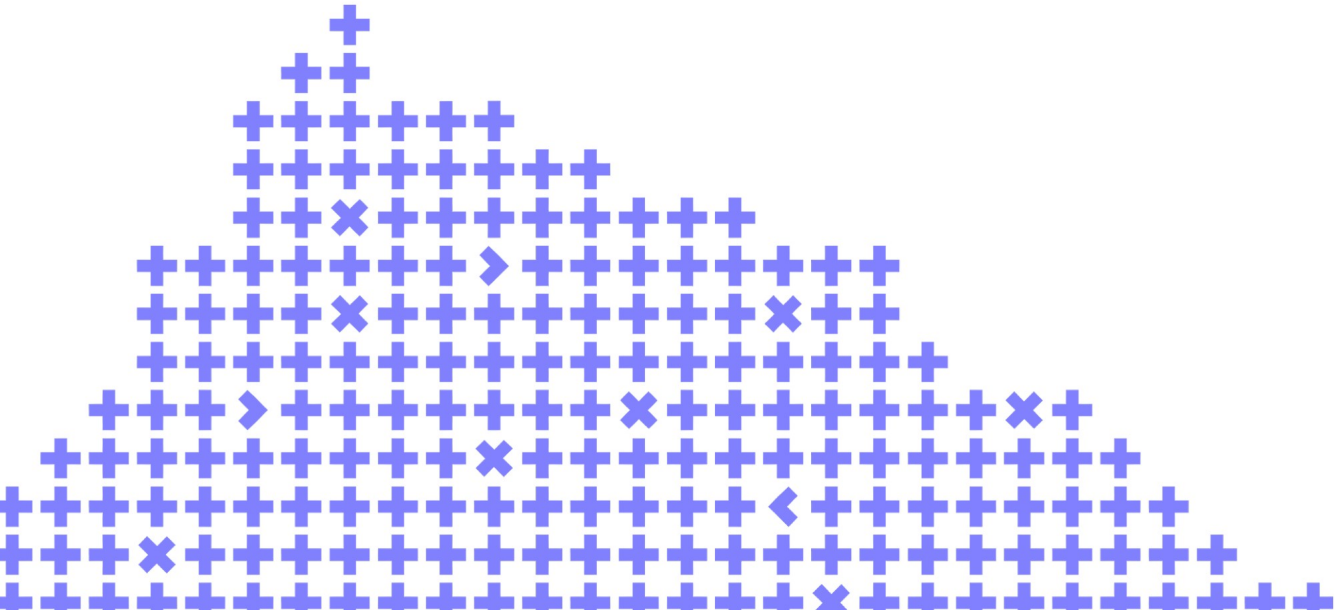
FPGAs will be more widely used in networking.

FPGAs will contain highly specialized silicon elements.

Machine learning is moving from GPU to FPGA… and momentum is growing.

FPGA may replace CPU and GPU as the main chip in the field of robot research and development in the future.

THANK YOU



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Co-organizer

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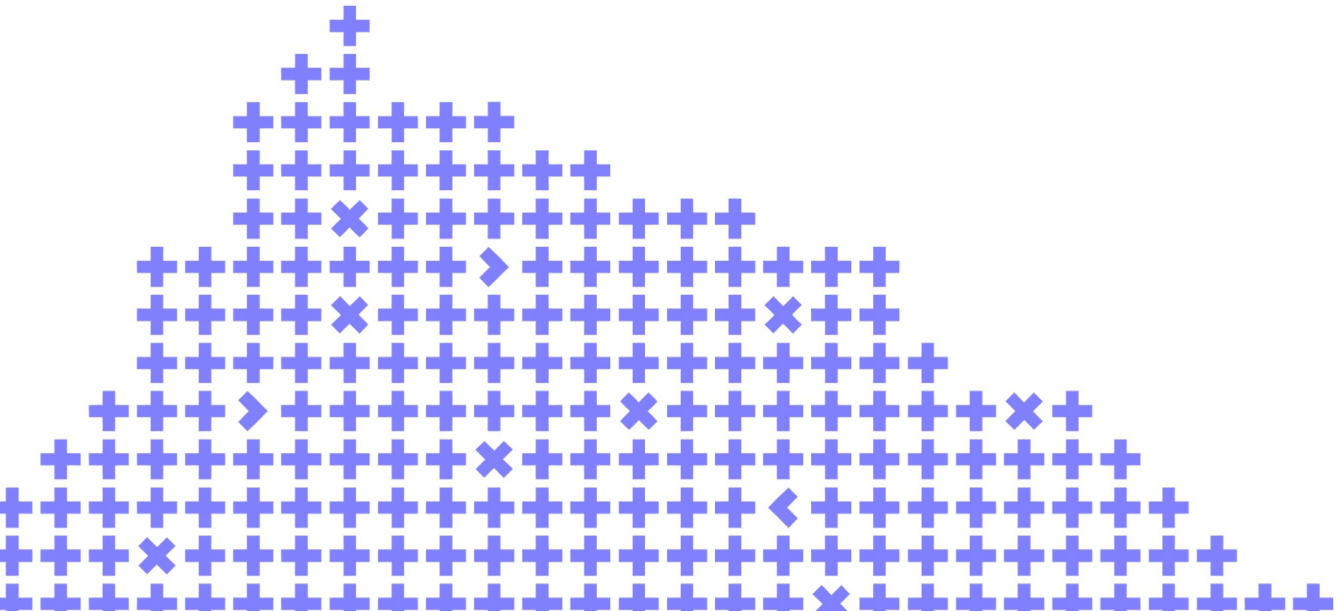
You can rate the talk and give a feedback on what you've liked or what could be improved



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